the Mecheleciv

Volume 25 October – 1966 No. 1

THE GEORGE WASHINGTON UNIVERSITY

OCTOBER 1966

Go Westinghouse, Young Man! *A modern fable with technical overtones.*

Once upon a time there was a young senior in college named Jack who couldn't decide about his future.

He wanted to do something worthwhile after graduation.

But there were so many things to do, it was hard to decide. He could go on to graduate school, or join the CIA, or volunteer for social welfare service, or participate in a protest movement . . . or he could enter the business world.

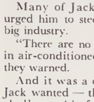
Many of Jack's friends urged him to steer clear of big industry.

"There are no challenges in air-conditioned offices," they warned.

And it was a challenge Jack wanted — the kind of challenge his forefathers faced on the frontiers.

Then he met a Mr. Greeley.

Mr. Greeley recruited college students for Westinghouse Electric Corporation. He was a kindly man to whom Jack opened his heart.



Mr. Greeley described to Jack the exciting things being done by Westinghouse all over the world.* Jack was fascinated and asked many searching questions about the world's 21st largest corporation. At the end of an hour, Mr. Greeley advised Jack:

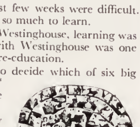
"Go Westinghouse, Young Man."

Jack did.

The first few weeks were difficult. There was so much to learn.

Jack was to discover that at Westinghouse, learning was a way of life, that a career with Westinghouse was one long process of education and re-education.

Later Jack was permitted to decide which of six big groups he would like to join.** Jack selected the Westinghouse Electric Utility Group.



With the Electric Utility Group Jack learned about water processing, about power generation, about underground distribution, and many other things. Jack had not realized how important to the survival of modern man is the world of electric utilities.

It was hard work. Sometimes after a particularly trying day Jack would get discouraged. Then he'd remember the warnings of his friends, back at college. And he'd wonder whether he had done the right thing.

Then came Jill. Pretty, intelligent, warmhearted Jill. Jack had met Jill at the drinking fountain in the Utility Group Water Province Department.

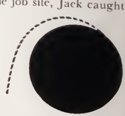
Jill was an engineer with Westinghouse (Editor's Note: Women are welcome at Westinghouse, an equal opportunity employer).

Although the work became more and more difficult and the hours longer, Jack with Jill at his side persevered.

Then came an assignment to join a team of Westinghouse engineers and scientists. The team was being sent to an underdeveloped nation in a faraway land to help rebuild a large coastal city.

Jack and Jill's assignment: Help build a power plant that would use nuclear fuel. (Nuclear fuel lasts longer than coal or oil. And it's cleaner.) Energy from the nuclear plant was used to change salt water from the nearby sea into fresh water that the poor people of this country could use as drinking water.

Working late one evening on the job site, Jack caught someone in the act of sabotaging the construction of an extra-high-voltage distribution system. This system would bring power from the nuclear plant hundreds of miles into the inland areas of the country.



After a dramatic chase through the winding streets of the city, a chase in which the international police and CIA participated, Jack captured the subversive agent. A grateful nation presented him with its highest award.

Finally, the project was completed. It was hard work but it was good work. Thanks to the Westinghouse team, millions of people would live better.

The citizens of the country were grateful. They wanted Jack and Jill and the others to stay . . . offered them more than their present salaries as an inducement . . . but Westinghouse fringe benefits more than offset this offer.

At the airport, where a sad but affectionate crowd of citizens gathered to see them off, Jack turned to Jill and asked:

"Will you marry me?"

Jill smiled and said: "I will if you promise to let me join you on other equally important turnkey projects that Westinghouse is coordinating in some of the major cities in the United States."

Jack promised, and they lived happily ever after.

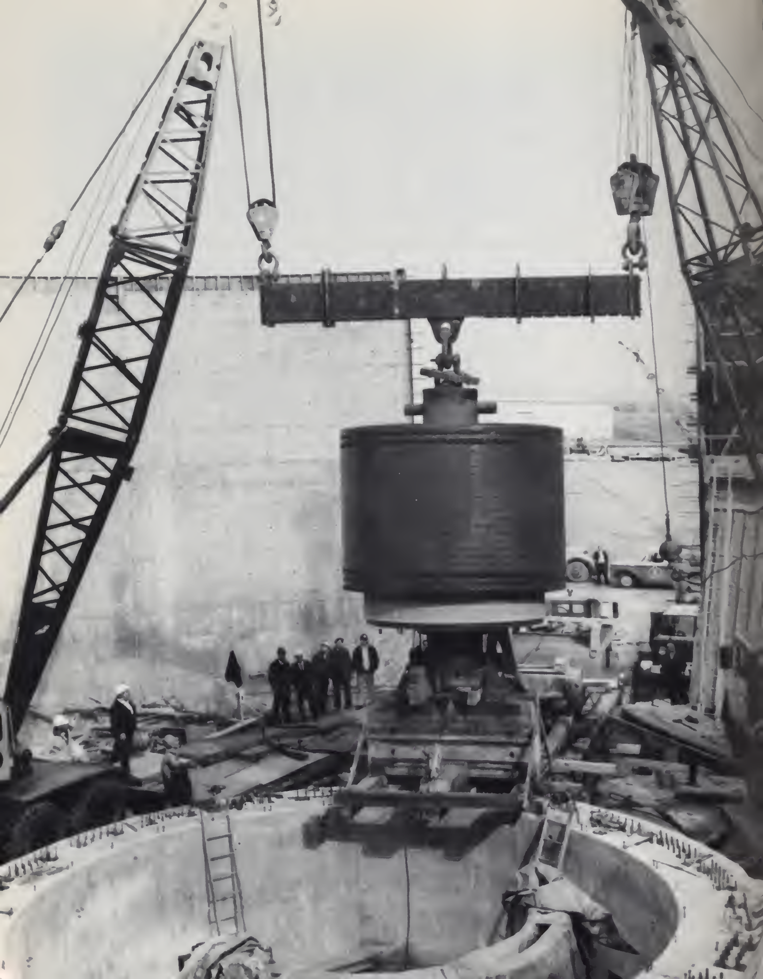
Moral: Awaiting you at Westinghouse are challenges, hard work, building block education, adventure, some travel and, yes, even romance.

You can be sure if it's Westinghouse

For further information, please contact: L. H. Noggle
Westinghouse Educational Center, Pittsburgh, Pa. 15221.

*UNDERSEA EXPLORATION MASS TRANSIT WATER DESALTING AEROSPACE TRAVEL AUTOMATED PARKING GARAGES PROGRAMMED LEARNING TOTAL-ELECTRIC CITIES

**CONSUMER PRODUCTS INDUSTRIAL CONSTRUCTION ELECTRONIC COMPONENTS & SPECIALTY PRODUCTS ATOMIC, DEFENSE AND SPACE ELECTRIC UTILITY



MECHELECIV

WHAT WILL YOU MAKE OF YOUR ENGINEERING SCHOOL?

Once again Tompkins Hall is filled with high school graduates eager to fill their heads with formulae and equations. These new students may not feel that they are a part of the school yet, but they really are and the Engineering School's future will be what they decide to make it. The school affords many opportunities for learning aside from the classrooms. These opportunities are in the form of meetings, field trips, and open forums which are announced to the students through notices and posters. There are no restrictions on who may attend these functions and any student who wishes to attend may do so even though he is not a member of an organization. The meetings usually consist of a very short business meeting, a guest speaker, and a movie. The field trips are taken to points of special engineering interest and are of great value to the student. Open forums are conducted by Sigma Tau, an honorary engineering fraternity, and usually involve the university faculty discussing university problems with questions being asked from the audience.

There are other activities in the Engineering School which may help the student to broaden his knowledge and versatility. The Engineering School has its own student government consisting of elected representatives from all levels of the school. Not everyone can be elected to the council, but all students are urged to talk with members of the council on matters concerning any phase of university life.

During each student's stay in the Engineering School he adds or detracts from the school as a whole. Since this school is his school it is his responsibility to improve or degrade it as he sees fit. Mecheleciv Magazine would like to welcome all students and hopes that your presence and actions will help make this one of the finest engineering schools in the country.

the Mecheleciv

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page

ARTICLES

DEPARTMENTS

COVER

An ordinary ant demonstrates the tiny size of integrated circuits. (Photo Courtesy of the Westinghouse Electric Corp.)

FRONTISPIECE

The world's most powerful DC motor (18,800 horsepower) will be used in NASA's new centrifuge to simulate re-entry of spacecraft at speeds of 42,000 mph (the speed of return from Mars). (Photo Courtesy of the Westinghouse Electric Corp.)

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WELCOME !

by Dr. Herbert E. Smith

It is the purpose of these writings to welcome this year's new students to the school of Engineering and Applied Science. While a personal welcome is extended of course, it is our intention here to welcome you to the professional study of engineering.

The School of Engineering is a professional school in a University which has a liberal arts college, a law school and a medical school among others. The University is the only private, non-sectarian institution of higher learning in the Nation's Capital.

What faces the student of engineering and applied science here at the George Washington University, and his life's work as an engineer? We hope to provide at least a partial answer as we seek to help you know what the study of engineering and science offers, what the differences are, what study in an engineering school such as The George Washington University's is like and then specifically what our purposes are, and how we approach the education of the engineer-applied scientist.

TODAY AS BEFORE

Engineers today, just as in the past, are engaged in the design and construction of bridges, tunnels, automobiles, aircraft, electrical and electronic systems and devices, to mention only several examples out of a myriad that exist. All of these projects, systems, construction, design, manufacture and fabrication are intended to improve and to preserve our way of life. A new factor has been added, however, which has a strong influence on what the engineer does and how he does it. We may call this factor the explosion of technology". What this really means is that the engineering applications of new scientific information, principles and theories that have been discovered, have acquired enormous potential for practical use and widespread applications in many areas. The realization of this potential is the domain of the engineer. The engineer can no longer design an airplane, a missile or a bridge using old methods, formulae, and even old materials, and feel that he is doing the best job possible. The door has been opened to an enormous amount of knowledge. Who can say, even today what the full potentials are of the laser, atomic energy, computers, titanium, cryogenics, and space travel? The application of principles, theories, new techniques, new devices, new forms of energy may be called "applied science". It is applied science which attempts to meet the urgent demands for putting these new tools to work for the earliest possible use by society. To meet this demand, an increasing number of engineers are engaged in research and development, which is really a general term describing what happens when an effort is made to take a basic principle, convert it to a first principle and convey it to a first model for production.

There are strong bonds between engineering and science.

The primary job assignments of all technical efforts may be classified as basic research, applied research, design and development, applications engineering, production or construction, service and operation, and administration. This is a wide spectrum of activity and requires the scientist, engineer, technician as a team. Between 15% to 20% of all engineers are employed in applied research. The largest single group of engineers work in design and development. The next largest groups are involved in applications engineering and production/construction. Applications engineering may be a new term for the reader. An applications engineer prepares the plans and designs for using a product to meet a specific need. A jet engine company's application engineer may work closely with an aircraft manufacturer who requires such engines as power plants in his aircraft.

Does this mean that at The George Washington University we do not reach electrical engineering, civil engineering, mechanical engineering, etc.? We do but, as in all modern schools of engineering we must attempt to prepare the student for the real world in which changes are taking place rapidly. We must emphasize the art and science of engineering.

MORE ENGINEERS . . .

Since an engineering education should prepare people for potential service in the wide spectrum of activity we have mentioned, most engineering schools aim their course programs somewhere between the applied research and design functions. The unique characteristic of an education in engineering today is the preparation of the individual for analysis, synthesis, and design of technical systems through a well-founded problem solving approach. Approximately 900,000 engineers are employed today in our country in industry, government, private research institutions and universities, according to the Bureau of Labor Statistics. Scientists number about 200,000. There is a good reason why there are more engineers than scientists. Industries have found there is a greater number of job functions which can best be filled by persons with an education in engineering.

Engineering is a professional field and anyone who desires to enter service in such a field

must have the appropriate specialized training. Additionally, it is important that he know something of our cultural heritage and the world in which he works and lives through study of the liberal arts and humanities. Engineering and liberal arts are not opposed, they are complementary. Furthermore, one's learning only begins in college. Throughout one's life there are many opportunities to learn, to gain familiarity with the many facets of our society, its government, its operations, its mores and customs and the issues which face our people.

What is the program of study in a school of engineering such as The George Washington University? The basics are (1) the pure science and mathematics, the physics, chemistry and calculus, (2) the applied science, such as electromagnetic wave theory, control theory, fluid mechanics, earth science, thermodynamics, astronomy, analytical mechanics, engineering materials, operations research and structural theory, (3) the engineering such as hydraulic engineering, structural design, reactor engineering, regional and urban planning, engineering electronics, computer and electrical laboratories, transducer and digital computer techniques, and (4) the general liberal arts studies.

MENTAL DISCIPLINE

The basic preparation in science and mathematics followed by courses in applied science and technology impose a discipline upon the engineering student which many other students in other areas of learning do not share. You have probably heard that the undergraduate engineers, as a group, work the hardest on campus. This is not because the courses an engineering student takes are, in themselves, more difficult than those taken by liberal arts students. The intellectual discipline or training of mind a student receives in engineering requires industry, but not a complete sacrifice of time. Disciplined mental activity is required in any study of professional areas. Good study habits, a capacity or determination for sustained application, a desire to accomplish your goals and ability to concentrate and to organize your work, are all essential qualities. Make an orderly approach to problem solving and persist in the face of difficulty. The effective management of time is basic. Does this mean there can be nothing but a steady, study grind? Many students have not found it so. The fact that an engineering student may find it necessary to put forth more effort makes the success all the sweeter.

Dr. Herbert E. Smith

SUCCESS

Success in engineering depends on your interest, enthusiasm, and motivation. Motivation depends to a large degree on a student's development. Lack of ability is seldom a reason for failure. Lack of motivation and failure to understand what engineering is, are causes for failure. Without these factors, the disciplined study will not come early. The requisite intelligence and good accomplishment in high school go a long way to determining fitness for engineering study, as well as study in many other fields. A famous American once said that the perpetually condemned man is one who does not make use of his talents whatever they are. The mind is not a storehouse to be filled by professors, but an instrument to be used. You determine your success more than anyone else. It is indispensable quality. Thomas Edison, for example, did not enter his laboratory and invent the electric light bulb. He did so only after repeated failures on which he capitalized. The only discouraging thing about failure is not making the most of it by profiting from understanding why the failure occurred.

It is our purpose in the School to assist you in any way we can with all our resources to help you to success. Those of us who have practiced engineering know how rewarding an experience it can be. In my case, it has brought me all over the world in many interesting and challenging projects. The experience in dealing with creative people has been a most satisfying life's work. We welcome you to your preparation for such work. That the School will have a part in shaping your future is a responsibility that we do not take lightly. We earnestly hope that you will recognize your responsibilities, develop as rapidly as you can, and fulfill your objectives.

CAMPUS NEWS

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
G.W.U. STUDENT CHAPTER

by Sethu Sekhar
Chairman

The members of ASME, GWU student chapter are proud to have you as a fellow-student at the School of Engineering.

Let me briefly describe here what ASME is and how it might benefit you.

ASME is a non-profit professional organization composed of some 60,000 members. Of these, about 9,000 are student members.

You are cordially invited to join as a student member. Student membership enables you to begin your professional development and to build important social and professional contacts at an early date. It provides you with a means to keep abreast of modern technology.

THIS YEAR'S EVENTS

During the coming year, we will have discussions, speeches and films of interest to potential engineers. In addition, we will also have several field trips that should be of interest to you. As a member of ASME, you will have the full opportunity to meet upperclassmen in your field whom you can ask for help if you have any difficulty in your courses. But you do not have to be a Mechanical Engineering major in order to qualify for membership.

After graduation, upon payment of your first year Associate Member dues, you will be promoted to Associate Member without further payment of an initiation fee.

MORE BENEFITS FROM THE SOCIETY

There are some immediate benefits you receive as a student member. You will receive twelve monthly issues of 'Mechanical Engineering' and five technical papers free of charge. You may compete for cash awards totalling $1700 in chapter, Regional, and National paper contests. There is also another small benefit. As a member of a professional society, you need pay only a nominal fee in order to enter the Annual Student-Faculty Pool Tournament. As you know all work and no play makes anybody dull, and ASME realizes this.

So come on, and talk to us. Our faculty advisor is Professor Barry Hyman (Room 314B).

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS
G.W.U. STUDENT CHAPTER

by John W. Lindsey
Chairman

The purpose of a student professional society is twofold:

1) To enable the engineering student make an intelligent and satisfying choice of field by acquainting him with as many phases of engineering as possible.

2) To increase the value and enjoyment of his education by bridging the gap which exists between industry and the classroom.

Our program this year is designed to satisfy these two purposes. The fall semester is a thorough review of power generation and distribution. It will be followed in the spring by a review of data and communications. Both spring and fall programs have been co-ordinated to show as clearly as possible what the industry is doing in each field.

CAMPUS NEWS

AMERICAN SOCIETY OF CIVIL ENGINEERS
G.W.U. STUDENT CHAPTER

by Eric S. Mendelsohn
Chairman

In taking this opportunity to welcome you to the George Washington University School of Engineering and Applied Science, I wish to briefly acquaint you with our purpose and endeavors as an engineering society student chapter.

THE CIVIL ENGINEER

Alfred R. Golze has described the civil engineer as an engineer who "plans, designs constructs, and operates those physical works and facilities essential to modern life. These include the highways that connect our cities, the streets within our cities, airports for our jet planes and spaceports for our spaceships, pipelines to transport our oil and gas, bridges to span our rivers and harbors, dams and levees to control floods and conserve water supplies, irrigation works to improve our farms, filtration plants and distribution systems for our municipal and industrial water supplies, and sewage-treatment wastewater recovery plants to maintain our health.

Working with architects and engineers of other disciplines, the civil engineer participates in the design and construction of office buildings, power plants, and industrial buildings. He is an essential factor, too, in the design and construction of military and space facilities. He participates in research to improve the art. He teaches in 144 accredited engineering schools. Civil engineers can become engineer-geologists, engineer-cost analysts, engineer-economists, and engineer-lawyers, as these combinations appeal to their personal interests."

THE CIVIL ENGINEERS' SOCIETY

Our purpose as a society is to afford all interested engineering students the opportunity to become more intimately acquainted with their future occupation, fellow students, and professors, and with practicing engineers within the profession. We attempt to do this by holding meetings at regular intervals featuring films and speakers on engineering subjects; participation in Engineering School activities, such as The Annual Engineers' Week, Annual ASCE Student Chapter Conference; and by making available the resources of the national society in the form of periodicals, financial support, and professional opportunities. National Society activities and resources are available in many instances to student chapter members at reduced cost.

We strongly recommend your participation in the program of the G.W.U. engineering societies both as an opportunity to add depth and meaning to your academic career and to further your chances for success through the contacts you make.

Professor Toridis will be more than happy to introduce you to a chapter officer and to provide information and membership applications. Dues are only \$3.00/yr or \$1.50/semester.

HONORS LIST
SPRING SEMESTER, 1966

The Faculty of the School of Engineering and Applied Science has provided for the recognition of meritorious scholastic achievement by the display and publication of an Honors List. The students whose names appear below have met all the requirements established by the Faculty for this honor.

As a matter of possible general interest, the honors list contains "... in alphabetical order, the names of candidates for an undergraduate degree in engineering whose scholastic achievement satisfies all of the following requirements.

a) The candidate's quality-point-index is equal to or exceeds 3.00 on 15 semester hours in one semester.
b) No grade below "C" has been received during the qualifying period.
c) No disciplinary action has been taken in respect to the student."

Amores, Arsenio
Ayre, Robert W.
Bawa, Harmohinder S.
Blumberg, Richard J.
Boehly, William A.
Bumbak, Andrew
Carosella, Michael E.
Carrano, Thomas
Cavanaugh, John T.
Cook, Michael S.
Cox, Barrington
Danisch, Lee A.
Foote, Kenneth
Forkois, Jerald L.
Friedlander, Jan E.
Ghadir, Yousef
Harman, Lowell K.
Herman, William A.
Huff, David L.
Hurley, Robert E.
Johnson, Paul B.
Kaul, Pradman P.
Keltie, Robert J.
Krauss, Philip D.
Kuhn, Harry A., Jr.
Lebeau, Francis S.
Lehman, Michael E.
Lemeshewsky, George P., Jr.
Lemeshewsky, William A.
Lewis, Garner L.
Lopez, Crawford X.
Maddox, Sterling R., Jr.
Manolatos, Telemachos J.
McSpadden, Thomas E.
Mendelsohn, Eric S.
Michael, Darel W.
Mollish, John M.
Moriarity, James M.
Murray, Edward R.
Pavlis, James D.
Rohrer, Michael W.
Rutiser, William A.
Saab, Miguel C.
Saidman, Perry J.
Schroeder, Curtis A.
Scott, John D.
Sekhar, S.
Standifer, Orville, Jr.
Steiner, Alan P.
Taylor, Douglas M.
Viehman, Michael J.
Weaver, Donald B.
Wong, James L.

MECH MISS . . .

MISS ELLEN HOUSE

Miss Ellen House hails from an engineering environment. This 18 year old freshman from Schenectady, N.Y. is the daughter of a G.E. electrical engineer.

October's "Mech Miss" has many diversified interests ranging from skiing and movies to music and reading.

Ellen finds many rewards and gains personal satisfaction in working with mentally-retarded children. Because of her interest she plans to major in special education here at G.W.

BIOGRAPHY: Cindy Levin
PHOTOGRAPHY: Lee Young and Sue Cole

THE MEASUREMENT OF TH

COEFFICIENT IN A LASE

by P.B. Mauer

INTRODUCTION

One of the fascinating aspects of a major scientific breakthrough is that it leads to a host of new and interesting challenges to the scientist and the engineer. The construction of the first successful laser in 1960 sparked new interest in many established areas of scientific investigation. This, in turn, has encouraged the optimization of laser performance, and stimulated a search for new materials and processes which will exhibit light amplification. Neodymium-doped glass was one of the first materials used successfully in solid state lasers, and has become one of the most prominent of the family of laser materials. The determination of the amplification coefficient of neodymium-doped glass is an example of one of the research problems which has grown out of the expanding laser technology. The method we shall describe here utilizes aspects of both theoretical and experimental approaches to the problem, and provides a relatively simple and precise determination of the amplification coefficient.

EXPERIMENTAL AND THEORETICAL DETERMINATION

A knowledge of the amplification coefficient of a laser material is basic to any calculation of the potential performance of that material as a laser amplifier or oscillator. This important parameter is expressed in terms of the gain in intensity per unit path experienced by radiation being transmitted through a medium. It is completely analogous to its negative counterpart, the optical absorption coefficient and is defined by

$$I = I_0 \exp(\beta x) \qquad (1)$$

where I is the intensity at some point x in the material, and x is measured along the path of the radiation from the point where the known initial value of the intensity, I_0, is incident. β is the amplification coefficient. β is, of course, a function of the energy stored in the rod. Hence we must express it as the amplification coefficient per cm, per joule of stored energy. In its most general form, the equation defining β should show a wavelength dependence. For our purpose, we choose to define β at the wavelength which gives its greatest value, ~ 1.06 microns.

The determination of the amplification coefficient may be made experimentally or theoretically. The choice is dictated by the difficulty of a direct calculation of β, which would require a detailed understanding of both the environment of the active ions, and the nonuniform host medium (glass). The direct calculation is possible, but the complexity of the material, and therefore the complexity of the computation, indicates that an experimental approach would be more fruitful.

In principle, β for neodymium-doped glass could be measured directly. Since it is the radiation produced in the electronic transition from the $^4F_{3/2}$ energy level to the $I_{11/2}$ level that is responsible for producing a gain in intensity at 1.06 microns (See Figure 3), it would be necessary to know how much energy is stored in the $^4F_{3/2}$ level and to compare this with the measured gain in intensity over a known path length of glass. Determining the number of ions in the $^4F_{3/2}$ level and to compare this with the measured gain in intensity over a known path length of glass. Determining the number of ions in the $^4F_{3/2}$ level (i.e. the stored energy) is, however, no mean task as it requires a knowledge of: the spectral and temporal output of the flashlamp, the absorption capability of the neodymium for this output, the efficiency with which the energy is transferred from the absorbing levels to the

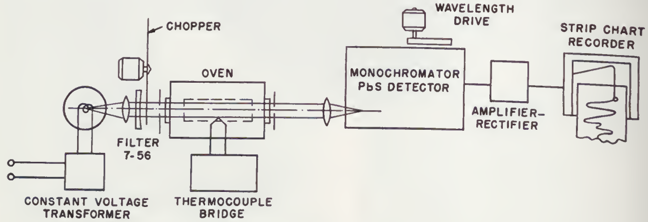


Figure 1

Schematic layout of components of a single-beam transmittance recording system.

MPLIFICATION

ATERIAL

$^4F_{3/2}$ level, the lifetime of the excited ions, and the efficiency of the optical coupling between the flashlamp and the absorbing neodymium ions.

We have developed[1] an indirect method for measuring β to avoid the complexity of these measurements. This method involves using the Einstein theory which relates the absorption cross section at 1.06 microns to the stimulated emission cross section at the same wavelength. It is important to remember that absorption at 1.06 microns can take place only from the $^4I_{11/2}$ level, a level which is populated only at elevated temperatures. Hence, the absorption coefficient is measured as a function of temperature and Boltzmann statistics are used to arrive at the absorption cross section. From the absorption cross section, the amplification coefficient follows directly for a given value of the stored energy.

INSTRUMENTATION

The essential device for measuring absorption as a function of temperature is a spectrophotometer equipped with a furnace in its sample compartment. There are two important demands which this type of measurement places on commercially available spectrophotometers. First, the radiation passing through the sample compartment should be chopped prior to entering the sample compartment. Since only the chopped, a-c signal received from the detector is amplified, this will prevent radiation from the furnace itself from being amplified. The second demand is that the high temperature regions of the furnace not be in a position where they can radiate into the sample beam, since this would increase the noise level of the measurement.

If such a spectrophotometer is not available, a simpler single beam system might be set up as illustrated in Figure 1. The various parts of the system may be described as follows:

1. Source - A small, low-voltage lamp driven by a constant-voltage transformer is adequate. A collimator lens is followed by a filter to remove short wavelength energy which would cause the neodymium-doped glass to fluoresce. A chopper modulates the light at a frequency to which the detector will respond.

2. Oven - A tube furnace equipped with windows can be designed to have a minimum temperature gradiant along its length. It should be provided with apertures which confine the measurement to the interior of the glass rod under test. A thermocouple is in physical contact with the rod to measure its temperature.

3. Monochromator - A wavelength resolution of 0.005 microns or better is necessary to read the peak of the 1.06 micron absorption band with accuracy. It is important to utilize a motor drive to smoothly scan the wavelength region from 0.9 to 1.2 microns. A collector lens images

the source lamp on the input slit, and the exit slit is imaged on a lead sulfide detector.

4. Output System - An amplifier which is tuned to the chopper frequency is followed by a suitable linear rectifier, and a strip chart recorder.

A modified commercial spectrophotometer of a single beam system like the one described above will produce a plot of transmittance as a function of wavelength. This plot will not, in general, show a straight line of 100 per cent transmission on either side of the absorption band because of the variation with wavelength of the transmittance of various elements in the system. Fortunately, these effects are slow functions of wavelength and may be compensated by a single interpolation which is demonstrated in Figure 2.

COMPUTATION OF THE AMPLIFICATION COEFFICIENT

After a number of measurements of the transmittance have been made in the 300° to 600° Kelvin temperature range and properly interpolated, the absorption coefficient, α , may be calculated from

$$\alpha = \frac{-1}{x} \ln T \tag{2}$$

where T is the fractional transmission and x is the length of the glass sample in centimeters. These values of α as a function of absolute temperature are the essential data for computing the amplification coefficient in neodymium-doped glass at 1.06 microns.

The three energy levels of neodymium which are important to the computation of the amplification coefficient from the absorption data are

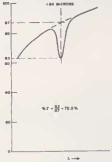


Figure 2

Interpretation of typical recorder trace to determine 1.06 micron transmittance.

Number	Energy	Level		Free Ion Degeneracy
2	1.42eV.	$^4F_{3/2}$		g_2 - 4
			1.06 micron Absorption	
1	0.25eV.	$^4I_{11/2}$		g_1 - 12
0	0eV.	$^4I_{9/2}$		g_0 - 10

Figure 3

Properties of the energy levels of neodymium ions involved in amplificotion coefficient meosurement.

shown in Figure 3. Again, as this diagram illustrates, only those neodymium ions in the $^4I_{11/2}$ energy state can contribute to the absorption at 1.06 microns. The number of ions, N_1, in the $^4I_{11/2}$ energy state is related to the temperature in the following way:[2]

$$N_1 = \frac{g1}{g0} \cdot N_0 \exp(-\Delta E/kt) \qquad (3)$$

where ΔE is the energy difference between the states, k is the Boltzmann constant (0.86 x 10-4 eV/°K), and t is the absolute temperature. The g's in Equation 3 represent the number of neodymium ion states which occupy the same energy level in the atomic system. The multiplicity of states at any energy level is called the degeneracy of that level.

The value of this indirect method can be seen in the manner in which α is used to determine the absorption cross section. Since α is directly proportional to N_1, a plot of ln α as a function of 1/t will yield a straight line with a slope of $-\Delta E/k$ A representative plot of this type is shown in Figure 4. N_1 is then determined since N_0, the number of neodymium ions present in the glass per cubic centimeter, does not vary significantly in the 300° to 600° Kelvin temperature range, and to a first approximation, the degeneracies can be taken as those of the free ion. N_1 may now be computed from Equation 3 at some temperature for which α has been measured. By dividing α by N_1, we arrive at a more useful quantity, the absorption cross section per ion, σ 12.

The next step in the computation of the amplification coefficient, β, is the calculation of the amplification cross section by:[2]

$$\sigma 21 = \frac{g1}{g2} \sigma 12 \qquad (4)$$

for then,

$$\beta = \sigma 21 N_2 \qquad (5)$$

and all that is necessary for a determination of β is the number of ions, N_2, which reside in the excited state ($^4F_{3/2}$).* We must relate this to the stored energy available in the 1.06 micron transition. Figure 3 shows that this is 1.17 electron volts, or 1,875 x 10^{-19} joules per excited ion. Then for each joule of stored energy we have

$$\beta = 5.34 \times 10^{18} \sigma 21 \qquad (6)$$

where β is the amplification coefficient per centimeter per available joule of stored energy.

Thus the method for measuring the amplification coefficient we have described here has employed parts of both experimental and theoretical schemes. In this way we have derived a simpler procedure than one which is either purely experimental or entirely theoretical. The utility of this method for determining the amplification coefficient in neodymium-doped glass is that it has been derived exclusive of the particular laser system in which the laser material will be used. This particular phase in our research at Kodak has been directed toward optimization of neodymium-doped glass and similar materials for use in solid state laser systems made by other manufacturers.

*A word of caution is in order regarding Equation (4). The degeneracies to be used here are not in general the degeneracies of the free ion since fields in the host glass cause some or all of these degeneracies to be removed. Since these fields are not, to date, well understood in glass, the free ion values have been used for preliminary results.

REFERENCES

1. P. Mauer, Applied Optics, Vol. 3, page 433, March, 1964.
2. Bela A. Lengyel, Lasers, John Wiley 1962, pp. 10-12.

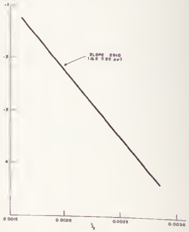
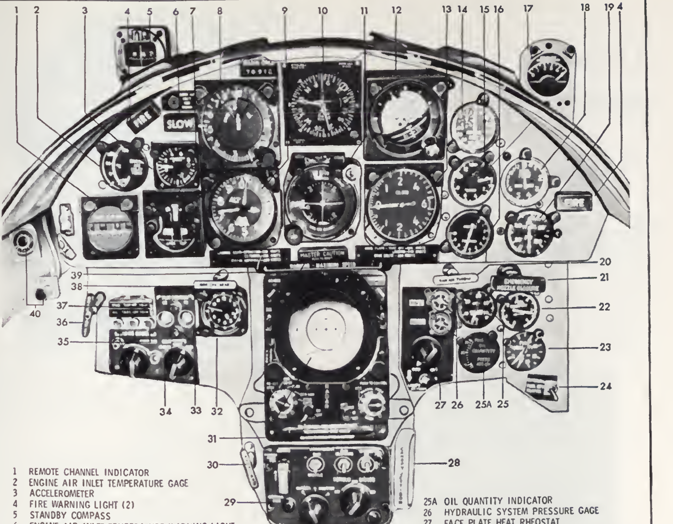


Figure 4

Representotive plot of ln α as a function of reciprocal temperature used in determining Δ E.



1 REMOTE CHANNEL INDICATOR
2 ENGINE AIR INLET TEMPERATURE GAGE
3 ACCELEROMETER
4 FIRE WARNING LIGHT (2)
5 STANDBY COMPASS
6 ENGINE AIR INLET TEMPERATURE WARNING LIGHT
7 TURN-AND-SLIP INDICATOR
8 AIRSPEED AND MACH NUMBER INDICATOR
9 ALTIMETER
10 BEARING DISTANCE HEADING INDICATOR ID-526 BDHI
11 COURSE INDICATOR (ID-249)
12 ATTITUDE INDICATOR
13 VERTICAL VELOCITY INDICATOR
14 TACHOMETER
15 EXHAUST GAS TEMPERATURE GAGE
16 EXHAUST NOZZLE POSITION INDICATOR
17 AUTOMATIC PITCH CONTROL INDICATOR
18 FUEL FLOW INDICATOR
19 OIL PRESSURE GAGE
20 RAM AIR TURBINE EXTENSION HANDLE
21 EMERGENCY NOZZLE CLOSURE HANDLE
22 INTERNAL FUEL QUANTITY INDICATOR
23 EXTERNAL FUEL QUANTITY INDICATOR
24 EXTERNAL FUEL QUANTITY SELECTOR SWITCH
25 CABIN ALTIMETER
25A OIL QUANTITY INDICATOR
26 HYDRAULIC SYSTEM PRESSURE GAGE
27 FACE PLATE HEAT RHEOSTAT
28 CANOPY JETTISON HANDLE
29 ARMAMENT CONTROL PANEL
30 RUDDER PEDAL ADJUSTMENT HANDLE
31 RADAR SCOPE AND CONTROL PANEL
32 CLOCK
33 WING FLAP POSITION INDICATORS
34 GUNSIGHT CONTROL SWITCH
35 LANDING GEAR POSITION INDICATOR LIGHTS
36 DRAG CHUTE HANDLE
37 STABILIZER AND AILERON TAKEOFF TRIM INDICATOR LIGHTS
38 MANUAL LANDING GEAR RELEASE HANDLE
39 MASTER CAUTION LIGHT AND RESET BAR
40 ARRESTING HOOK RELEASE BUTTON AND ARRESTING HOOK DOWN WARNING LIGHT

So you want to be a pilot?

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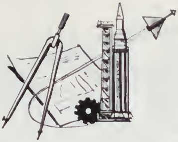
TECH NEWS



PAUL BUNYAN IN THE SKY

The giant, 175,000-cubic-foot Vee-Balloon, built by Goodyear Aerospace Corporation and operated by Bohemia Lumber Company, "flys" two towering logs across the Wilametta National Forest near Eugene, Ore. When used in combination with a high-speed winch, the new "super-skyhook" is capable of carrying up to 10 tons of logs at one time at distances of up to half a mile. The new balloon was demonstrated at a press conference staged by the two companies and the U.S. Forest Service, which is evaluating the use of balloon logging for clearing previously inaccessible timberland.

INDEX TO ADVERTISERS

WORLD'S LARGEST TIRES AND EARTH-MOVING SCRAPER

The world's largest and strongest tires have been built by B. F. Goodrich Tire Company for the largest earth-moving scraper ever built.

Eight 10-foot-high tires, each capable of carrying 50 per cent more load than the biggest earth-moving tires now on the market, are used on an "electric digger" designed and manufactured by the R. G. LeTourneau Company of Longview, Texas.

The scraper-digger, over 2/3 as long as a football field, will scoop up 720,000 pounds of earth in 1-1/2 minutes without help from pusher tractors. Present earth-moving scrapers rely on auxiliary tractors for much of the power needed for rapid loading.

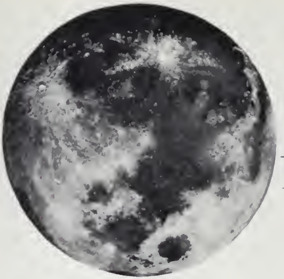
Besides their record load-carrying capacity, the tires for the digger are able to transmit nearly a million pounds of tractive force.

The digger's electric drive system permits nearly all of the machine's 6080 horsepower to be used for traction when it is needed. To handle this force without slippage, the tires have a width of five feet and a heavy bar-type tread design which makes them resemble huge gear wheels.

B. F. Goodrich and LeTourneau engineers worked jointly on the design of the tires. LeTourneau manufactured the tire mold and B. F. Goodrich designed and installed special equipment to manufacture the tires at its Miami, Oklahoma, tire plant.

The tires are tubeless and made with Nylon cord. They are 72 ply-rated and weigh nearly 6,000 pounds each.

The electric digger is so called because the power from its diesel engines is converted to electricity which powers electric motors in each wheel.



ENGINEERS' QUEEN 1966

ELLEN JO WEBER

Each year the Engineering School chooses a girl, sponsored by the societies, as its queen. The girl chosen as the Engineers' Queen is the candidate representing the Engineering School for Homecoming Queen of the following year. A group of judges selects the top 5 candidates and these 5 girls are voted on by the student body.

Last year Ellen Weber was elected as Engineers' Queen. Ellen has a very good chance of being in the top 5 candidates for Homecoming Queen and will win with the support of the Engineering School in the elections in November.

ENGINEERS' COUNCIL ELECTIONS

Petitioning for Engineers' Council Offices will open on Monday, October 3, and will close on Friday, October 14. Balloting will take place on Thursday, October 20, and Friday, October 21, on the second floor of Tompkins Hall.

The positions that will be filled are two on the freshman level, for which any first semester freshman may petition, and one on the introductory level for which any engineer with less than 70 hours may petition. Petitioning forms will be distributed around Tompkins Hall.

THE SHAFT

An E.E. student was perched outside a third story window of Harrington Hall. A fellow student made his way out to persuade him not to jump.

"Think of your mother and family."

"Don't have any."

"Well, think of your girl friend."

"I hate women."

"Life is so beautiful, why would you want to end it?"

"I only got a 93 on my Electronics test."

"Jump, you damn curve wrecker."

* * *

Mother: "Do you like your new nurse, Jimmy?"

Jimmy: "No, I hate her. I'd like to grab her and bite her neck like Daddy does."

* * *

Psychology Prof: "If I saw a man beating a mule with a stick and I stopped him, what would I be showing?"

Voice (from the rear of the room): "Brotherly love."

* * *

Overheard in a Zen Coffee-Urn:

First Cat: (Very Down) Soooo like, I bought her a scotch, Y'know, so dig, one sip man and she's all over me. She says "Lets widen to your pad", so we split and she's got her clothes off and on the stairs, man, and in the kip she was like the end, baby! She was the wildest! On one sip of Scotch, man!....

Second Cat: (Unresponsively) Groovy, so why so bugged?

First Cat: Man . . . I think I coulda had her on a beer.

* * *

Prof: "Well, what did you think of the course?"

M.E.: "I thought it was very well covered. Everything that wasn't covered during the semester was covered on the final."

A story going the rounds concerns three pregnant squaws who slept on animal skins--one, on an elk skin; another, on a buffalo skin; and the third on a hippopotamus skin. The first squaw had a son; the second, a son; and the third, twin boys. Which proves: The squaw of the hippopotamus is equal to the sons of the squaws on the other two hides.

* * *

It was the first time she had been to dinner with them, and he smiled indulgently as she refused whiskey and soda.

"I never touched it in my life," she explained.

"Why not try it?" urged the host. "See if you like the taste."

She blushed and shyly consented, and he poured her out a mixture which she delicately put to her lips.

After the first swallow, she grimaced and placed the glass on the table. "This isn't bourbon it's Scotch!"

* * *

A housewife went to the grocery store and got some eggs and catsup, then she stopped in the neighborhood bar where she dropped her groceries and made the biggest mess you ever saw. A drunk looked down, patted her on the shoulder and said, "That's all right lady, don't cry . . . it wouldn't have lived nohow, the eyes are too far apart.

* * *

In Hungary, a commissar asked a peasant how the potato production was coming along.

"Oh, fine," answered the peasant. "We have so many potatoes that if we put them in a pile, they would reach clear up to God."

"But, you know there isn't any God," replied the commissar.

"Well, there aren't any potatoes either," said the peasant.

A sweet old lady, always eager to help the needy, spied a particularly sad-looking old man standing on a street corner. She walked over to him, preseed a dollar into his hand and said, "Chin up."

The next day, on the same corner, the sad old man shuffled up to the lady and slipped ten dollars into her hand.

"Nice picking," he said in a low voice. "He paid nine to one."

* * *

The farmer was "assisting" at the birth of his latest child--he was holding the lamp. When the doctor delivered three fine babies, the farmer suddenly left the room.

"Come back with the lamp!" yelled the doctor.

"Nope," was the reply. "Ain't comin' back Doc! It's the light that's attractin' them."

* * *

While riding home from work one evening, three commuters became friendly in the club car and after the third round, they began to brag about the relative merits of their respective marital relationships. The first proudly proclaimed, "My wife meets my train every evening, and we've been married for ten years."

"That's nothing," scoffed the second, "my wife meets me every evening, too, and we've been married seventeen years!"

"Well, I've got you both beat, fellows," said the third commuter, who was obviously the youngest in the group.

"How do you figure that?!" the first fellow wanted to know.

"I suppose you've got a wife who meets you every evening, too!" sneered the second.

"That's right," said the third commuter, "and I'm not even married!"

How dull if everybody who joined us had the same aims, color, and interests!

The guy who wrote what you are reading joined the company as an optical physicist. Now he's an advertising man. His assistant, an English and French major from Catawba College in Salisbury, N.C., who first joined our French affiliate, Kodak-Pathé, in Paris, has just written a manual in English that introduces beginners to a system of separations chemistry for which we market equipment and supplies. Her husband works in our Photographic Technology Division engineering color motion-picture processing systems. (Four other departments tried to lure him away, but he decided he preferred the exciting new development work in his area.) The chairman of our board also came originally as a physicist, the president as a mathematician, one of our two executive vice presidents as a chemical engineer, the other as a Ph.D. chemist. On the other hand, our vice president of marketing majored in economics at the local university.

The point: out of self-interest, pure and frank, we have to help every college graduate who joins us find where he is happiest and can therefore earn raises fastest. What makes this a little easier here for both parties is our tremendous scope.

Having long been part of many, many more industries than the one with which the general public identifies us, we operate in technologies that range from optics to cattle nutrition, from knitting to laser-cavity design. Perhaps more significant to the person choosing an affiliation for the long haul, we have room and need for every shade of personal bent. In most people personal bent is still to be discovered at the time of college graduation.

The general public knows us for snapshots and home movies. We like it that way. Actually, 72% of our sales comes from elsewhere.

One makeup is tuned for avid pursuit of better understanding of the physical world, whatever the purpose. He can enjoy himself here. Another will enjoy himself here far more in tough competition to create demand for the ultimate fruits of the first fellow's studies. One technical talent finishes what the other technical talent starts. To man the long line between them, we have urgent need for just about every other honest technical talent, male or female, all creeds, all colors. That's how broad we are.

Chat with our representative on campus or drop a note about yourself to Director,* Business and Technical Personnel Department, EASTMAN KODAK COMPANY, Rochester, N.Y. 14650.

*The engineer who previously occupied that position has been promoted to associate director of the Photo Technology Division. One of his former assistants then moved up to the job.

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